The Space Industry, Enterprise Architecture, and Knowledge Management

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(with help from Information Dynamics)
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Draft 1

Outline

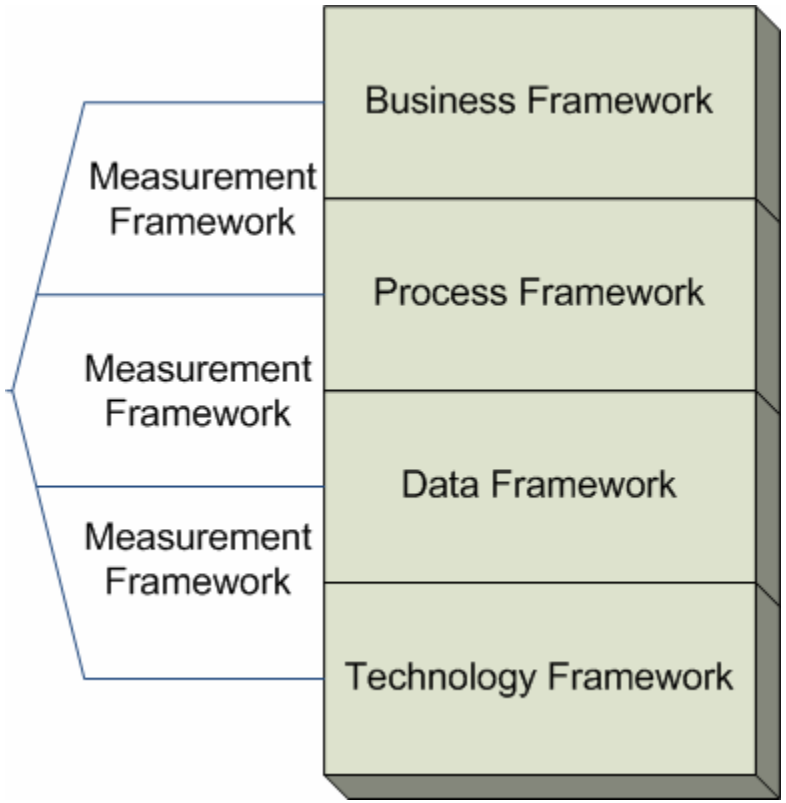
- Global Space Industry Challenges
  - Reduce cost of developing flight systems
  - Radically reduce the cost and risk of transporting pressurized, non-pressurized, and human cargo to and from orbit
  - Reduce the cost of collecting, analyzing, and disseminating data
- Knowledge Management as lever; Enterprise Architecture as fulcrum
  - What is Enterprise Architecture
  - EA as ontology and core of taxonomy
  - Hierarchical decomposition of requirements following ontology and core taxonomy of Space Industry Enterprise Architecture
  - Business requirements first!
  - KM and Product Lifecycle Management
    - ESMD use case
- How can we get there from here?
    - Top down architecture driven not bottom up taxonomy driven
    - Spiral development with **very** small teams
    - Disciplined tool selection and use processes
  - Apply EA methodology to the development of KM
    - Training, dissemination, and collaboration
  - We can both hang together <u>and</u> hang separately

What is EA

What is Enterprise Architecture

- Business driven focused methodology designed to maximize return on investment for industry and government
- Business, process, data, and technology component layers with cross cutting measurement layer
- Use iterative, recursive subdivision within each layer while maintaining traceability to higher layers

Enterprise Architecture Framework



Federal Enterprise Architecture
Consolidated Reference Model (CRM) v2.1

Business Reference Model (BRM)

- Lines of Business
- Agencies, customers, partners

Service Component Reference Model (SRM)

- Service domains, service types
- Business and service components

Technical Reference Model (TRM)

- Service component interfaces, interoperability
- Technologies, recommendations

Data Reference Model (DRM)

- Business-focused data standardization
- Cross-agency information exchanges

Performance Reference Model (PRM)

- Inputs, outputs, and outcomes
- Uniquely tailored performance indicators

Decompose Each Reference Model

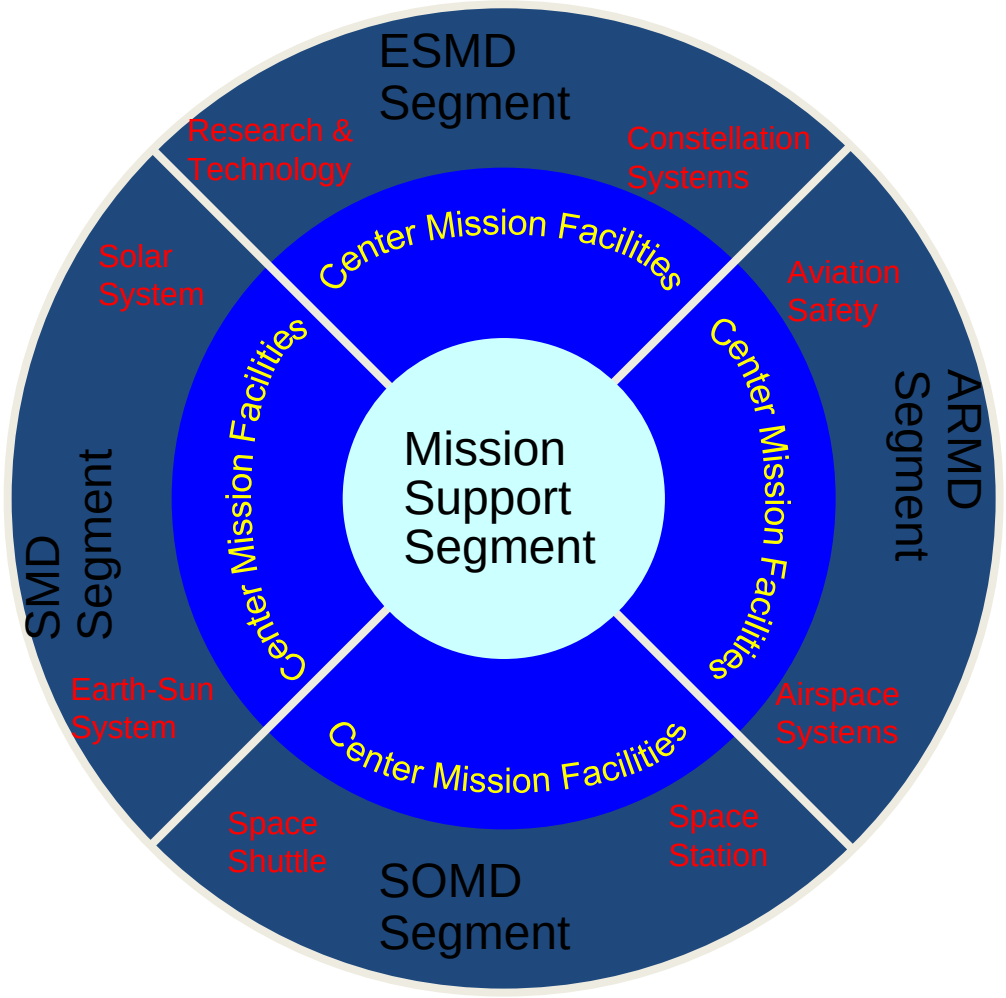
- What business is the space industry in?
  - Research
    - Scientific
    - Engineering
    - Human factors
  - Development
    - Launch systems
    - Payload/Information systems
      - Human and robotic
      - Robotic
  - Flight
    - Physical payloads to the atmosphere
    - Physical payloads to orbit
    - Physical payloads from orbit to ground
    - Data payloads to orbit and ground

For Example

- What business is NASA in?
- How can we deconstruct it?

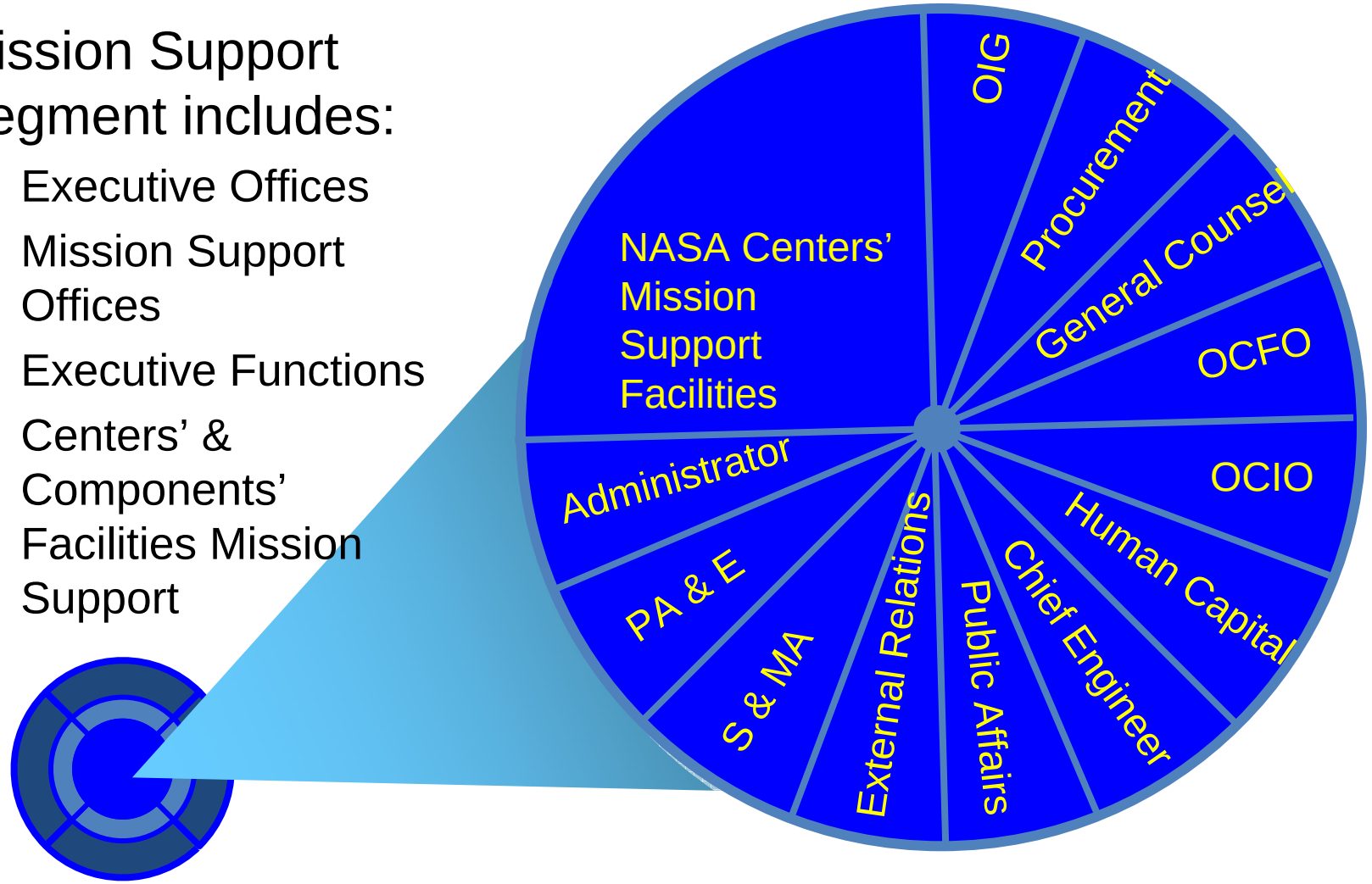
NASA Enterprise Architecture Overview

- NASA's Enterprise Architecture has 5 Segments:
  - One for each Line of Business
  - One for cross-cutting capabilities
- Each business Segment has its own unique operational elements: (e.g., …)
  - SOMD - Shuttle
  - SMD – Earth Sun
  - ESMD - Constellation
- Business Segments rely on services provisioned through the Mission Support Segment



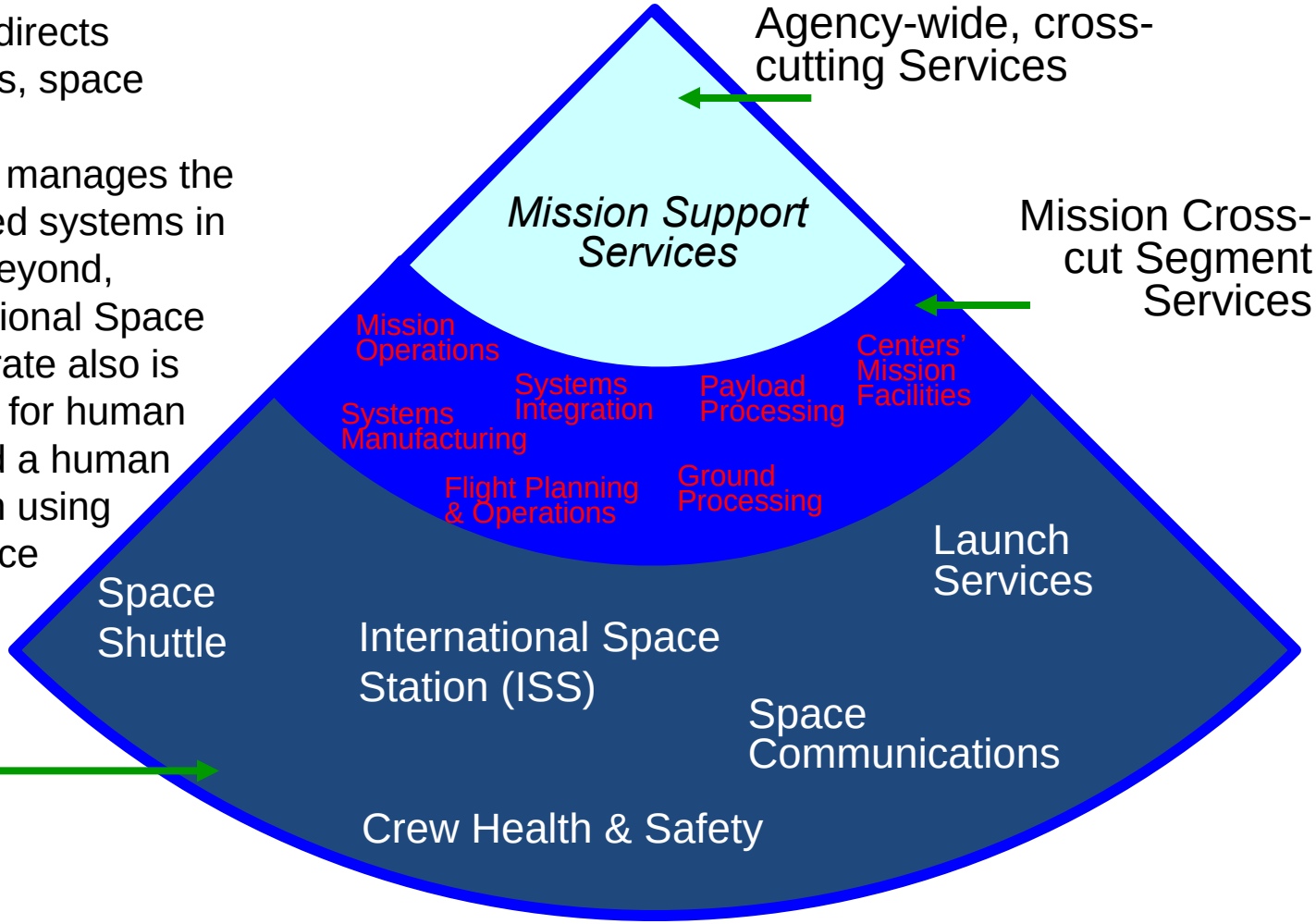
Mission Support Segment

- Mission Support Segment includes:
  - Executive Offices
  - Mission Support Offices
  - Executive Functions
  - Centers' & Components' Facilities Mission Support



SOMD Segment

The Space Operations Mission Directorate (SOMD) directs spaceflight operations, space launches, and space communications and manages the operation of integrated systems in low Earth orbit and beyond, including the International Space Station. This Directorate also is laying the foundation for human missions to Mars and a human lunar outpost through using the International Space Station.



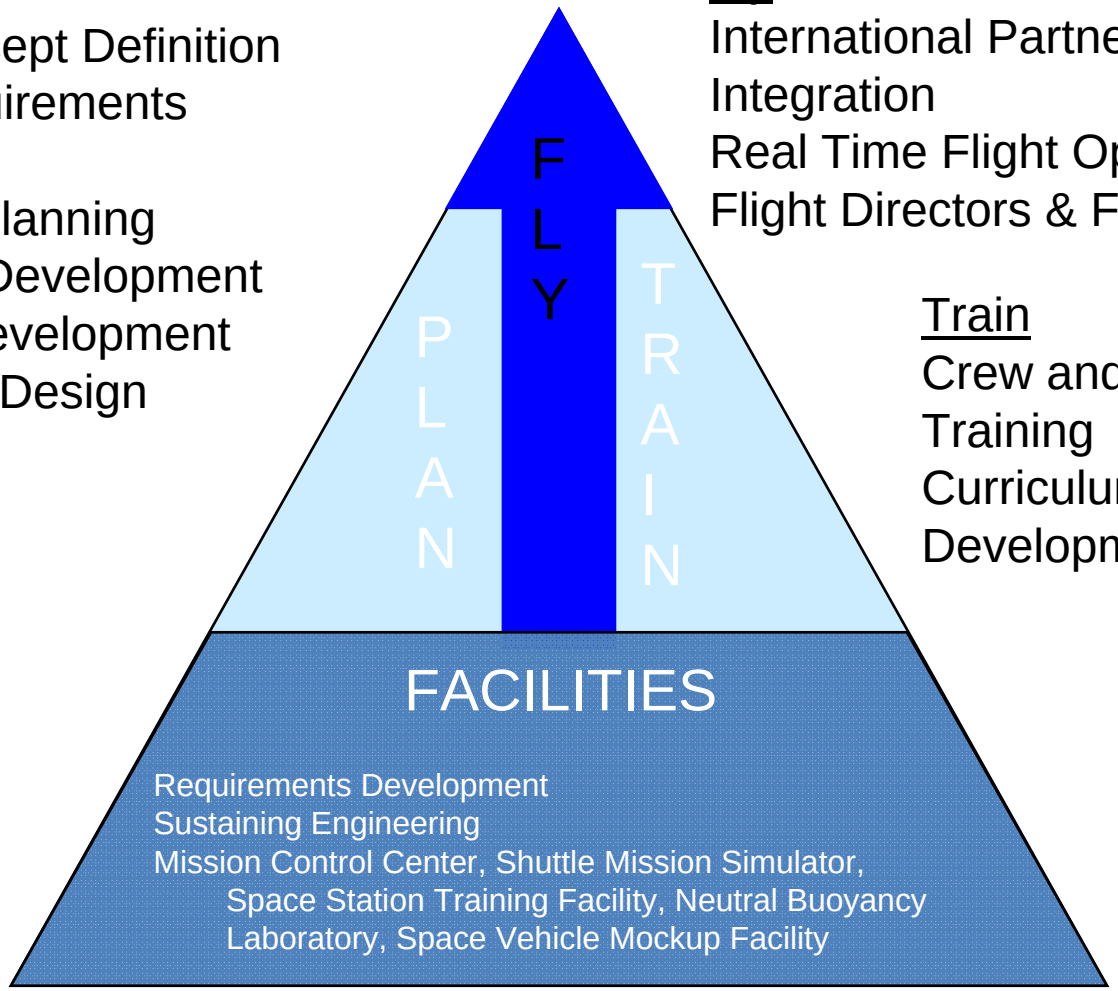
SOMD Cross-Cutting Services

Mission Operations Overview

Plan
Mission Concept Definition
Mission Requirements Integration
Flight Crew Planning
Flight Rules Development
Procedure Development
Analysis and Design

Fly
International Partner Operations Integration
Real Time Flight Operations
Flight Directors & Flight Controllers

Train
Crew and Flight Controller Training
Curriculum Design & Development



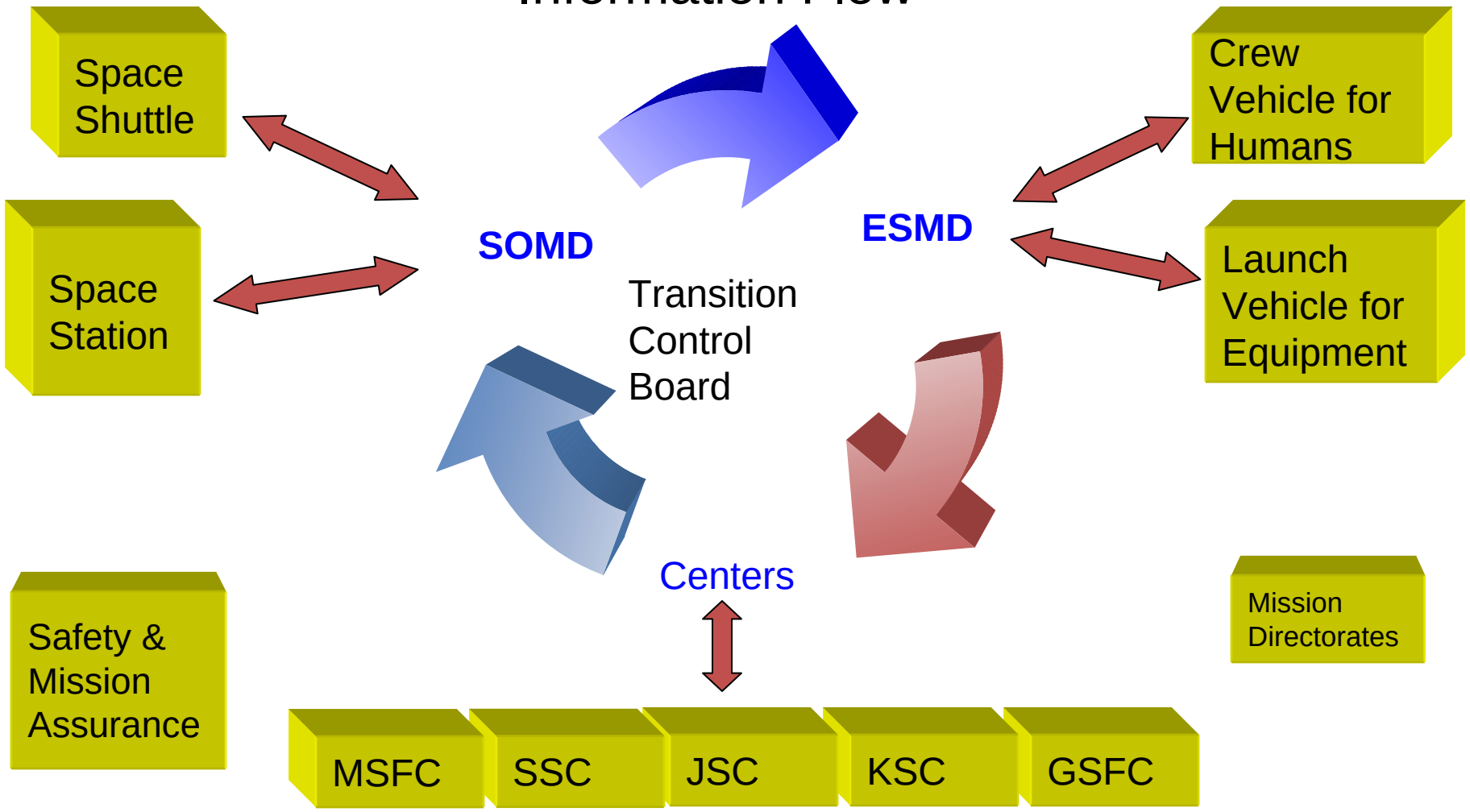
Example
ESMD Deconstruction To Propulsion Systems

- ESMD
  - Research and Technology
  - Constellation
    - Crew Launch Vehicle
      - Ares I
        - » Propulsion Systems
          - MSFC Systems Integration
            - Main Engines
            - Second stage engine
              - Rocketdyne J2X

High Level SSP to CxP Architecture Example

Space Operations Resource Transition

Information Flow



SRB Transition Strategy

Framework For Future Systems

LEGEND
1. System is sufficient and will require no upgrades
2. System remains necessary but will have to undergo modification or upgrade
3. System will be decommissioned, but performs a useful function that must be maintained by an alternative
4. System will be decommissioned
5. Not Applicable

• Shuttle decommissioned in 2010
• Reuse SRB's

• Use 5-segment SRB's for future launch vehicles

Collect Information

Current State
SRB Systems

Transition
SRB Systems

Future
SRB Systems

Current Data Sources

OMB 300s
IT Security Plans
Technology Plans

Systems Inventory Generated

Review System Attributes

Develop Framework

WBS
RFPs
Expert Knowledge

Automated Booster Assembly Checkout System
Building Automation System
Booster Launch Operations Center
Boosternet ; High Pressure Wash Facility
SRB DESKTOP

Map Systems to Framework

Determine Disposition of Existing Systems

Determine Gaps & Outstanding Requirements

Ontology and Taxonomy

Ontology (Computer Science)

- From Wikipedia, the free encyclopedia
- In both computer science and information science, an **ontology** is a data model that represents a set of concepts within a domain and the relationships between those concepts. It is used to reason about the objects within that domain.

Taxonomy

- From Wikipedia, the free encyclopedia
- **Taxonomy** is the practice and science of classification. The word comes from the Greek *τάξις*, *taxis*, 'order' + *νόμος*, *nomos*, 'law' or 'science'. Taxonomies, which are composed of ***taxonomic units*** known as ***taxa*** (singular ***taxon***), are frequently hierarchical in structure, commonly displaying parent-child relationships.

EA and KM

- Use KM as a collection of levers
- EA as a consolidating fulcrum
- Use Enterprise Architecture as the organizing framework and process for deconstructing business drivers, processes, data architecture, and technology
- Use this organizing framework as the foundation for KM ontology and automatically tag all program artifacts accordingly
- Develop detailed taxonomies as subordinate to the architecture derived ontology
- Explicitly tie KM investments to EA defined business objectives

KM as Human Processes

- The human element should either be:
  - Developed as Level 1 and 2 cross cutting processes. For example:
    - Communities of Practice
    - Lessons Learned
    - Structured Collaboration
  - As elements within all program and project processes
    - Meta data tied to architecture derived ontologies and taxonomies

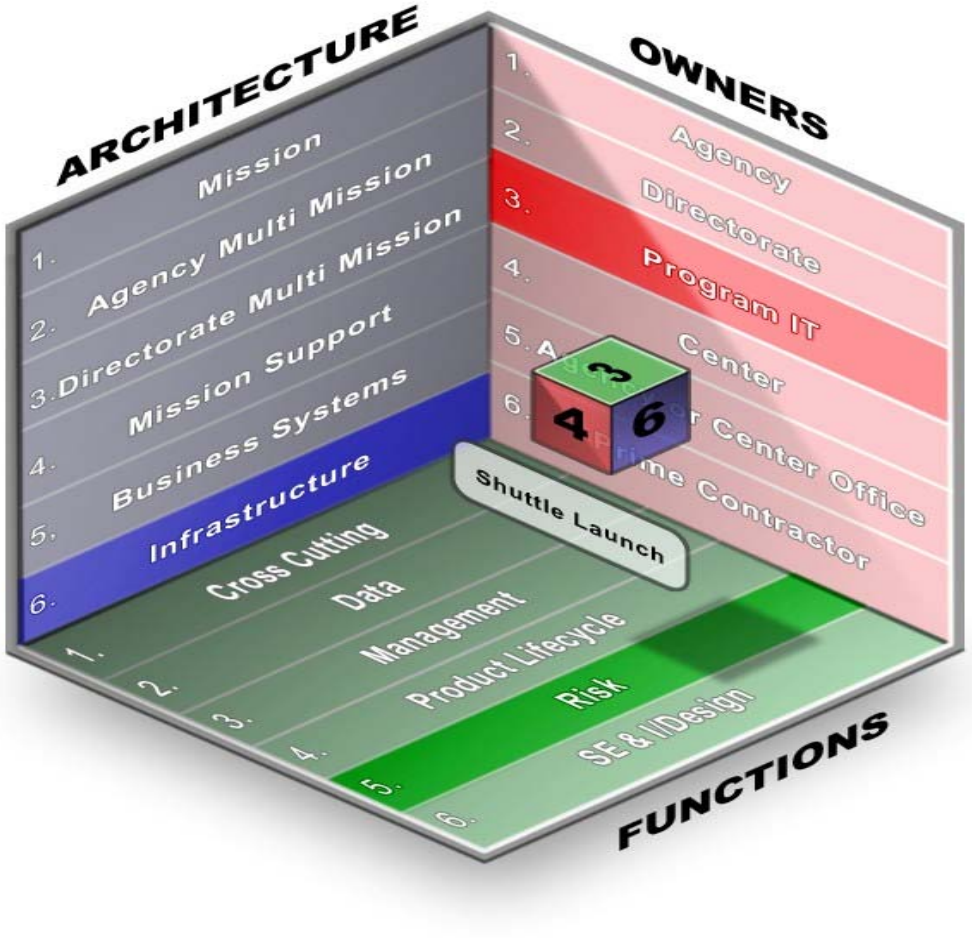
Business Drivers for KM

- Life cycle cost and risk reduction
- Tactical cost and risk reduction
- Organizing discipline for Product Lifecycle Management
  - MSFC Ares Propulsion Example
- Horowitz PLM use case
  - CEV disabled on the way to the moon
    - As was and as is – Apollo 13 clip when Krantz takes team into small conference room to figure out what to do – point is that they were all there, knew the systems intimately, had design documents and expertise right there – and while we are in better shape today with SSP we are still HIGHLY dependent on Genius's with photographic memories in leadership roles to integrate and coordinate – it simply can't happen now
    - To be

IT Governance and Enterprise Architecture

<to be written>

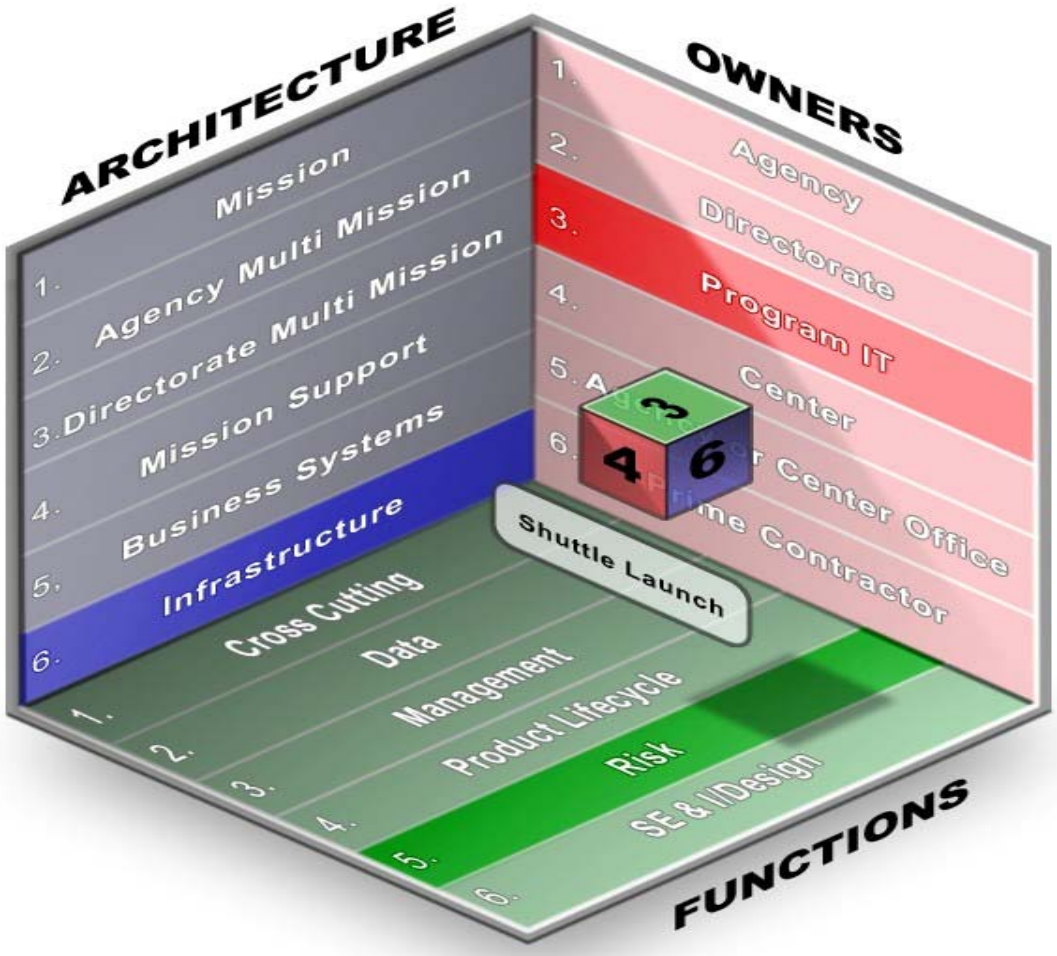
Enterprise Architecture and Tool Selection



From Here to There

- As an international industry, we must codify our tacit knowledge of our “As Is” architecture.
- As a Federal Agency, we MUST take the OMB EA reporting requirements and focus the resources being expended to develop an agency mission EA that both meets the promise of reducing lifecycle cost and risk and that meets the KM requirements discussed earlier
- We must work in very small teams at first with an iterative, recursive approach to the analysis, document production, and coordination using a COP model with well defined and tested collaboration processes
- As a community, we must work to support Directorate and Agency efforts to establish a disciplined, professionally managed mission IT tool process
  - We must stop treating tools are our “iron rice bowls”

Architecture Cube Example for Tools Architecture



We Can Hang Together and Hang Separately

- Use a community of practice approach to integrate the KM and EA communities
- A COP approach supports the eventual integration of ontologies and taxonomies developed by SMEs at the project and element level
  - MSFC Propulsion Systems example
  - Rocketdyne example
- Inexpensive Space Industry focused EA training is available in both short course (Information Dynamics - http://www.information-dynamics.com), in formal certification courses (FEAC Institute - http://www.feacinstitute.org/), or as consulting services
- Me: chris@chrispino.com; 240-535-5801

But must work together using EA to set the beat

<clip – chain gang clip from Brother Where Art Though>